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English to Japanese translation of selected passages of Japanese Laid-Open Pat. Appl. 11-168064.

(54) Title: Stage driving method, stage device, and an exposure device.

(57) [Abstract]

[Subject] To provide a stage device whereby it is difficult for moment, deformation force, and so on to occur when restricting the oscillation caused by powering a needle.

[Means of Resolution] A stable plate (3) is supported on a base (1) by an oscillation proof platform (2A), etc. Situated on the stable plate (3), which slides freely along the X guide bar (4), is an X stage that comprises a Y guide bar conveying body (5), a guide bar (6), etc. This X stage is driven in the X direction by the X axis linear motors (10A), (10B). Stators (12A), (12B) of X axis linear motors (10A), (10B) are supported such that they can be moved in the X direction atop the stable plate (3) by direct drive guides (13A), (13B). By means of X break members (36A), (36B) installed in a brake frame (35) secured to the base (1), a breaking force is applied to the stators (12A), (12B) to counterbalance the reaction force when the X stage moves.

[0042] Following is an explanation of a Y axis breaking mechanism. First, as shown in Figure 1, a needle (32) outfitted with a coil is secured to a Y guide bar conveying body (5) together with a connecting member (9) that moves in the X direction, and a stator (33) whose cross-section has a backward "C" shape is arranged along the X direction so as to cover the front tip of the needle (32) in a non-touching way. The stator (33) is secured to two brake frames (34A), (34B) secured to the +Y direction of the lateral side of base (1). To serve as a Y axis breaking mechanism, a Y break motor (31) is constructed from the needle (32) and the stator (33). As the partial cutaway of the stator (33) in Figure 2 shows, the stator (33) is arranged to cover the needle in the entire range of the needle's (32) X direction motion.

[0043] Figure 3(a) is a top-down diagram of a partial cutaway depicting a Y breaking motor comprising the needle (32) and the stator (33) of Figure 1. Figure 3(b) is a lateral view of same. As depicted in Figure 3(b), permanent magnets (39A), (39B) are secured on one side of the interior of three yokes (37), (38A), (38B), which themselves are secured in the form of a backward "C", so as to invert polarity in the Y direction, and permanent magnets (39C), (39D) are secured on the other side of this interior at a polarity that competes with and opposes permanent magnets (39A), (39B). Consequently, the direction of magnetic flux generated between the pair of permanent magnets (39A), (39C) on one side is opposite that of the magnetic flux generated between the pair of permanent magnets (39B), (39D) on the other side, and the needle (32) is inserted between these two pairs of permanent magnets in a non-touching way.

[0044] As shown in Figure 3(a), a coil (32a) is wound around in a square pattern multiple times inside the needle (32). In this case, the current IY flowing in the coil (32a) is in the +X direction between the first pair of permanent magnets (39A), (39C) and in the mutually opposite –X direction between the other pair of permanent magnets (39B), (39D). If, for argument's sake, a

breaking force DY/2 consisting of a Y direction Lorentz's force acts on the needle (32) between permanent magnets (39A), (39D), a breaking force DY/2 consisting of Y direction Lorentz's force acts on the needle (32) between permanent magnets (39B), (39D) as well. Since the Lorentz's force is proportional to the current IY, the total Lorentz's force can control the direction and size of the DY breaking force in a free manner by controlling the current IY.

[0045] In Figure 5, then, data about the thrust supplied from the wafer stage driving system (53) to the Y axis drivers (56A), (56B) is also supplied to the driver (58). The driver (58) sets the current IY supplied to the coil (32a) of the needle (32) so that the breaking force DY comprised of the Lorentz's force DY is, by means of the total value FY of thrust applied to the needles (16a), (16B) of the double-axle Y axis linear motors (26A), (26B), the same size as, and has opposite direction of, the reaction force at work on the needle (32).

[0046] Thus in Figure 1, with the thrust FY of the needle (17a), etc. (specimen stage [15]) in Y direction owing to the Y axis linear motors (26A), (26B) (see Figure 2), the reaction force –FY (size FY reaction force in the –Y direction) acts on the stators (16a), (16b) (see Figure 2) and, by way of a connecting member (9), on the needle (32) of the Y break motor (31). In a corresponding way, a break force DY having the same size as, but the opposite direction of, this reaction force operates on this needle (32) in direction Y by means of the Y breaking motor (32). Hence, Y direction oscillation occurs neither in the needle (32) nor, by extension, in the stable plate (3). In the Y axis driving mechanism as well, the reaction force generated by the Y axis linear motors (26a), (26B) and the breaking force applied by the Y breaking motor are on about the same level. Thus, no large moment, deformation force, and so forth occur.

[0047] Even if at this time the X direction position of the specimen stage (15) in Figure 2 were to change, the needle (32) is housed in the stator (33) and a breaking force could be applied to the needle (32) to counterbalance the constant Y direction reaction force. Thus, regardless of the X direction position of the X stage, the stable plate (3) is still even when the Y stage decelerates in the Y direction. Consequently, highly accurate positioning control and speed control of this Y stage, and by extension of the specimen stage (15), can occur.

[0048] As shown in Figure 4, moreover, the permanent magnets and coil of the breaking motor (31) of Figure 3 can be reversed. In other words, Figure 4(a) is top-down diagram depicting a different structural example of a Y breaking motor (31). Figure 4(b) is a lateral diagram of same. As shown in Figure 4(b), the needle (32A) in this variant is built of permanent magnets (42A), (42B) secured on one side in the interior of three yokes (40), (41A), (41B), which are themselves secured in a backward "C" shape, to invert polarity in the Y direction, and of permanent magnets (42C), (42D) secured in the other side of the interior at a competing polarity opposing permanent magnets (42A), (42B). Furthermore, a stator (33A) lengthwise in the X direction is inserted between these two pairs of permanent magnets in a non-touching way so as to cover the full range of motion of needle (32A).

[0049] As Figure 4(a) depicts, coil (33a) is wrapped in a square shape multiple times inside the stator (33A). In this variant, then, when electric current passes through the coil (33a), the Lorentz's force the stator (33A) generates between the permanent magnets (42A), (42C) and the Lorentz's force the stator (33A) generates between the permanent magnets (42B), (42D) are in the same direction, and the reaction force of the total of these Lorentz's forces acts on the needle (32A) as a breaking force. This breaking force counterbalances the reaction force FY acting on the needle (32A), whereby Y direction oscillation can be restrained.

[0050] In the aforementioned embodiment, moreover, X breaking members (36A), (36B) equal to the needles (11A), (11B) of the X axis linear motors (10A), (10B) are used as X axis breaking mechanisms. However, the stators (12A), (12B) to which this breaking force is applied are coupled by way of direct drive guides (13A), (13B) to the stable plate (3) so as to move freely in the X direction. Thus, even with large variations in the thrust applied to the X stage from the X axis linear motors (10A), (10B) and in the breaking force applied to the stators (12A), (12B), as well as in the shift volume, no X direction force will act upon the stable plate (3). Hence, a structure with a higher degree of freedom, and possibly cheaper, can be adopted. Hereafter, another embodiment of this sort of X direction breaking mechanism will be explained. To simplify the explanation, though, only the mechanism breaking the stator (12a) of one X axis linear motor (10A) will be discussed.